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At the northern edge of the plate is that remarkable stream of nebulosity running nearly in a straight line southward from *ζ Orionis*. The curious embayment (*a* in the key map) is distinctly visible on the accompanying plate. Dr. Roberts' photograph does not show the whole of the southern part on account of the restricted size of his field. The linear nebulous arm is really curved farther south, going more eastward, and in this stream, in

$$\alpha = 5^{h}\ 37{\cdot}1^{m} \qquad \delta = -3^{\circ}\ 7' \ (1900{\cdot}0)$$

is a second bay (*b* in the key map) similar in form and size to the other.* This bay contains three fine stars free of nebulosity. The eastern neighbourhood shows several curved rifts in the nebulosity. It is impossible here to describe the whole in detail, but I would call attention to three places where the woven nebulosity is exceptionally beautiful :

	R.A. 1900. h	Decl. 1900. ° ′
(*a*)	5 33·6	−5 18
(*b*)	5 31·5	−6 43
(*c*)	5 33·7	−7 9

The concentration (*a*) forms a striking flat ring resembling a smoke ring. The concentration (*b*) is a pretty cloud somewhat similar to the "trifid" nebulæ. Its centre is the B.D. star −6°·1252 of the 9·3 magnitude. The third concentration (*c*), consisting of several bright clouds and dark channels, has much resemblance to the cloud following *ζ Orionis*. The fainter parts embrace the 5th magnitude star B.D. −7°·1152 = *d Orionis*.

Königstuhl-Heidelberg Astrophysical Observatory :
1903 *February*

On the Period and Light Curve of (7514) *UY Cygni.*
R.A. = $20^{h}\ 52^{m}\ 16^{s}$, *Decl.* = $+30^{\circ}\ 2'{\cdot}8$ (1900).
By A. Stanley Williams.

The observations on which the following results are based number altogether 238, and consist of 12 photographic observations from plates taken with a 4·4-inch portrait lens, 41 visual observations made with a 2¾-inch refractor, and 185 made with a 6½-inch reflector. But 15 of these 238 observations were rejected owing to their having been marked as uncertain, or as

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* For the history of this nebula see the note by Miss Clerke to my article in the *Journal Br. Astr. Assoc.* 1890, p. 252.

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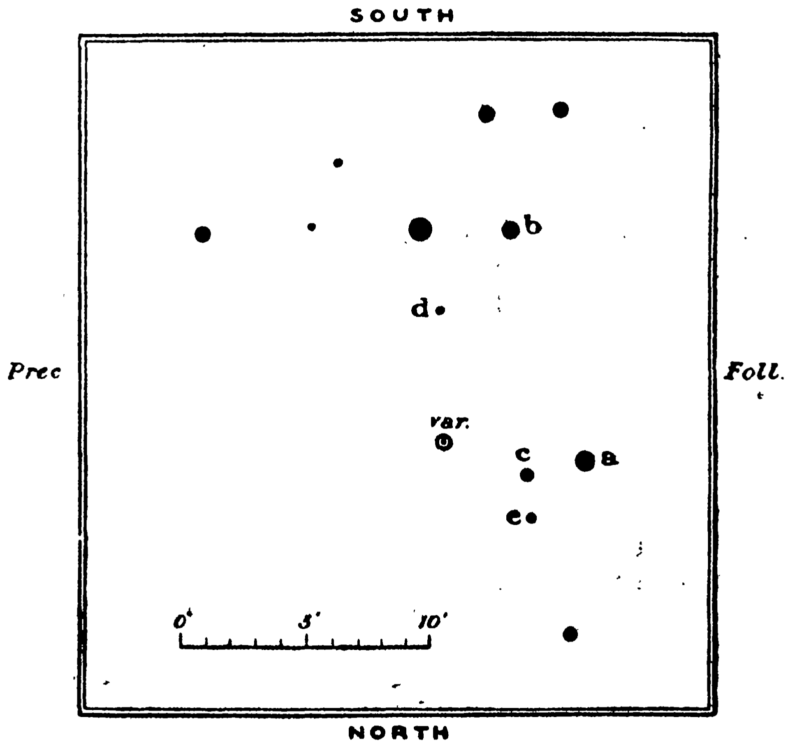
possibly affected by cloud or fog;* two on account of the time not having been recorded; and six for discordance. One observation in addition was accidentally omitted, so that the actual number made use of is 214.

Most of the observations were made with the $6\frac{1}{2}$-inch reflector and a power of 73, and these have been considered as standard, and the other observations have been reduced so as to conform to them. It had at first been intended to use the reflector observations alone, at any rate for the purpose of constructing the light curve, but the others on reduction agreed so well with these on the whole, that they likewise have been employed. A few of the refractor observations were, however, given half weight.



The observations were generally made in the form of short sequences of steps, the sequence commencing usually with the comparison star *a* and ending with *d* or *e*. A light scale having been formed from about 50 such sequences observed with the reflector, all the observations, including those made with the refractor and the photographic observations, were as far as possible reduced to this scale.† The photographic observations

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* Cloud and fog were abnormally prevalent in 1902, adding much to the difficulty of satisfactorily observing very rapid variables.

† The value of a step varies somewhat from night to night as regards the same group of stars, and even on the same night in the case of different groups. This is in conformity with the statement by Professor H. C. Wilson,

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were reduced on the assumption that the photographic light changes are the same as the visual; an assumption which would not be correct if, for instance, the star underwent any decided change of colour in the course of its variations in brightness. As, however, the photographic observations when thus reduced agree satisfactorily with the visual ones, it is evident that the photographic variation is substantially the same as the visual, so far as regards this particular star. In making the visual observations the head was always so held that a line through the eyes was parallel to a line joining the two stars compared, in order to eliminate the effects of "position error."

The comparison stars used will readily be identified by means of the preceding little diagram, in which the brightest star shown is B.D. + 29°·4240 (8·3 mag.). The brightness of each comparison star according to the adopted light scale is given below, together with the corresponding magnitude on the assumption that the magnitude of the star *c* is 10·20, and that the value of a step is 0·05 magnitude.

Comparison Stars.

Star.	Scale.	Magnitude.	Star.	Scale.	Magnitude.
a	36·4	8·81	*d*	0·2	10·62
b	26·1	9·33	*e*	0·0	10·63
c	8·6	10·20			

Owing to the unfavourable weather the number of completely observed maxima is not so large as had been desired, and in order to secure the best results it was found necessary to make use of a mean light curve. This provisional light curve was constructed in the following manner. The observations of the different maxima having been independently charted upon *transparent* squared paper, the results were superimposed one upon the other, and adjusted so as to correspond as closely as possible to what seemed to be the mean result. The superimposed sheets of squared paper were then held up to a bright light, and the mean curve carefully drawn. This resulting provisional light curve, it may be mentioned, is almost identical with the final light curve based upon all the observations, and reproduced in Plate 12. The exact times of maximum were then derived with the help of this provisional light curve from the separate observations of each night. The observed times of maximum are given in Table I. below. The weights in the last column were assigned at the time when the different maxima were determined.

when discussing the numerous observations of Nova *Persei*, to the effect that the value of a step was for most of the observers a variable quantity (*Popular Astronomy*, vol. ix. p. 481). In the case of the present star the observations were in most cases reduced so as to make the step value correspond to the mean, or standard, step value of the adopted scale.

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TABLE I.

Observed Maxima.

No.	Ep.	Date.	Geoc. G.M.T.	Red. to ⊙	Helioc. G.M.T.	O–C.	Wt.
		1900.	h m	m	h m	m	
1	0	Nov. 22	10 55	−0·4	10 54·6	− 1·0	1
		1902.					
2	729	Jan. 5	5 43	−4·8	[5 38·2]	[+86·3]	½
3	1038	June 27	11 22	+3·8	[11 25·8]	[+83·4]	...
4	1040	„ 28	12 28	+3·8	[12 31·8]	[−25·2]	...
5	1063	July 11	11 5	+5·1	[11 10·1]	[+44·2]	¼
6	1072	„ 16	11 40	+5·5	11 45·5	+13·2	¾
7	1138	Aug. 22	11 29	+6·5	11 35·5	− 1·6	¾
8	1145	„ 26	9 32	+6·5	9 38·5	−10·1	1
9	1147	„ 27	12 29	+6·5	12 35·5	− 7·6	1
10	1186	Sept. 18	9 34	+5·8	9 39·8	+ 9·9	1
11	1293	Nov. 17	9 13	+0·3	9 13·3	− 2·7	1

The first maximum, it should be mentioned, is photographic. The variable appears distinctly brighter upon this photograph than it does upon any of the others, and for this and other reasons it seems pretty certain that the star was either at, or at any rate very near, its maximum brightness at the time; whilst the long interval by which this observation precedes the others renders it of special value for determining the period of variation. The plate in question was exposed for one hour, from $10^h\,25^m$ to $11^h\,25^m$, on 1900 November 22; and a note states that the sky was rather hazy, particularly towards the end, when the altitude was lower. Under ordinary circumstances the maximum brightness of the variable would no doubt occur before the middle of the exposure, owing to the increase being more rapid than the decrease. But in the present case the greater haziness towards the end would tend to equalise matters, and the middle of the exposure has consequently been assumed as the actual time of maximum. The third and fourth maxima were observed by Dr. Hartwig at the Bamberg Observatory.* The bracketed maxima were not used in determining the period of variation.

From the data contained in the foregoing table the concluded elements of maximum are :—

Maximum = 1902 August 22, $11^h\,37^m{\cdot}1$ G.M.T. + $13^h\,27^m\,20^s{\cdot}85$ E.†

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* See *Vierteljahrs. der Astron. Gesells.*, Jahrgang 37, Heft 3, p. 284.

† This period is $61^s{\cdot}26$ longer than that published by the writer in the *A. N.* 3771, and it would seem that in connecting the observations of the autumn-winter of 1901–02 with those of the previous year one period too many must have been assumed. This would account for the disagreement between the predicted and the observed times mentioned by Hartwig (*loc. cit.*).

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and the residuals according to these elements will be found in the penultimate column of Table I. With reference to these, it may be mentioned that the maximum No. 2 is based only on observations made a considerable time after maximum, and in fact it rests practically upon a single observation; whilst one of the two untimed observations, previously referred to, follows this one and shows that the star was probably estimated too bright at the first observation. The details of the two maxima observed by Hartwig are not at present known to me. In the case of maximum 5 the observations (five in number) are discordant *inter se*, and these five observations have consequently been rejected altogether, and they are included in the list of six observations rejected for discordance as already mentioned.

Owing to the great rapidity with which the rise from minimum to maximum takes place, the time when the variable attains to equality with the comparison star *c* can be observed with great exactness; in fact with greater accuracy than can the actual maximum. This time is denoted by T_0, and Table II. contains the observed times of T_0 and other data corresponding to Table I. It will be seen that the residuals are here very small; so that similar observations in future years should enable the period to be ascertained with great exactness.

TABLE II.

Observed Times of T_0.

No.	Ep.	Date 1902	Geoc. G.M.T. h m	Red. to ⊙ m	Helioc. G.M.T. h m	O–C m	Wt.
1	1138	Aug. 22	10 10	+6·5	10 16·5	− 0·1	1
2	1145	„ 26	8 23	+6·5	8 29·5	+ 1·4	1
3	1147	„ 27	11 18	+6·5	11 24·5	+ 1·9	1
4	1186	Sept. 18	8 27	+5·8	[8 32·8]	[+23·5]	¼
5	1293	Nov. 17	7 52	+0·3	7 52·3	− 3·2	1

The mean light curve has been derived by arranging all the observations in order of the interval by which they follow the last preceding maximum, and then forming them into groups, and taking the means. For about two hours before and after maximum the observations have been formed into 15-minute groups, and for the remainder of the period into half-hourly groups, with the exception of one group, which is an hourly one. The reduction to the Sun has been effected for all observations made when the star's brightness was changing rapidly. The resulting mean values were then plotted upon squared paper on a large scale, and a smooth curve drawn carefully through the dots representing the mean results. This final mean light curve is given on a smaller scale in Plate 12. The data upon which it is based are contained in Table III. Column 4 of this table gives the magnitude from the mean light curve, derived

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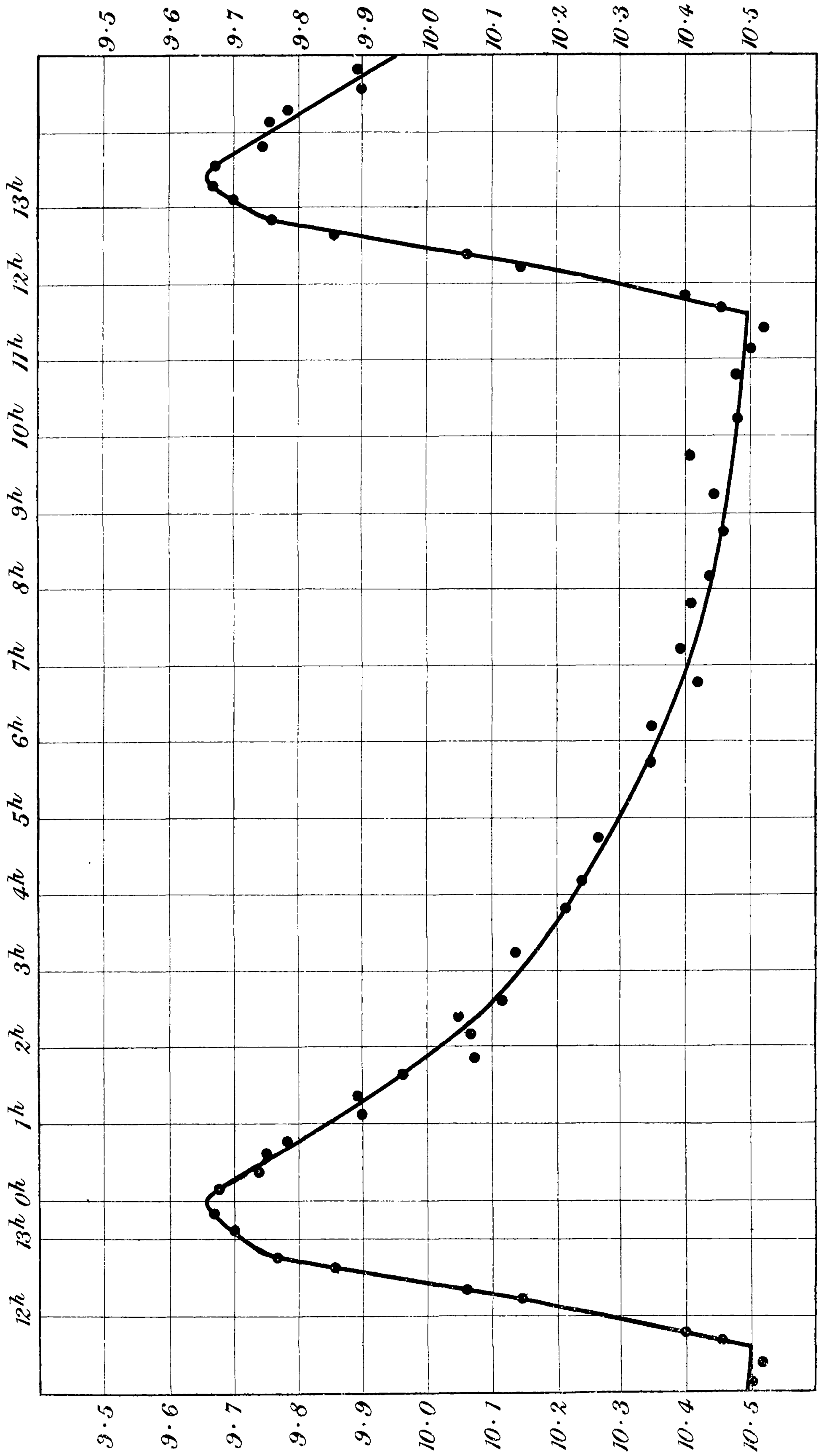

LIGHT CURVE OF UY CYGNI.

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from the large scale diagram referred to above; and column 5 the difference between the observed brightness and the brightness according to the curve. The mean difference, without regard to sign, is 0·019 magnitude; whilst the largest difference only amounts to 0·07 magnitude.

TABLE III.

Grouped Observations.

No.	Interval from prec. maximum h	m	Observed Magnitude	Magnitude from curve	O – C Mag.	No. of Obs.
1	0	8	9·67	9·68	–0·01	7
2	0	26	9·73	9·73	·00	5
3	0	39	9·75	9·77	– ·02	5
4	0	50	9·78	9·80	– ·02	3
5	1	7	9·90	9·87	+ ·03	7
6	1	23	9·89	9·92	– ·03	5
7	1	39	9·96	9·96	·00	7
8	1	51	10·07	10·00	+ ·07	6
9	2	8	10·06	10·04	+ ·02	8
10	2	22	10·04	10·08	– ·04	4
11	2	42	10·12	10·12	·00	6
12	3	15	10·13	10·17	– ·04	5
13	3	49	10·22	10·22	·00	8
14	4	14	10·25	10·24	+ ·01	7
15	4	44	10·27	10·28	– ·01	6
16	5	40	10·34	10·33	+ ·01	9
17	6	14	10·34	10·36	– ·02	6
18	6	47	10·42	10·39	+ ·03	4
19	7	15	10·39	10·41	– ·02	8
20	7	47	10·41	10·43	– ·02	5
21	8	13	10·43	10·44	– ·01	10
22	8	49	10·46	10·45	+ ·01	3
23	9	15	10·43	10·46	– ·03	7
24	9	43	10·41	10·47	– ·06	9
25	10	14	10·48	10·48	·00	6
26	10	45	10·48	10·49	– ·01	4
27	11	7	10·50	10·49	+ ·01	10
28	11	26	10·52	10·49	+ ·03	5
29	11	38	10·46	10·46	·00	6
30	11	51	10·40	10·33	+ ·07	5
31	12	11	10·14	10·14	·00	5

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No.	Interval from prec. maximum. h m	Observed Magnitude.	Magnitude from curve.	O−C Mag.	No. of Obs.
32	12 22	10·06	10·04	+ ·02	4
33	12 37	9·85	9·89	− ·04	4
34	12 53	9·76	9·76	·00	5
35	13 8	9·70	9 70	·00	4
36	13 23	9·67	9 67	·00	6

It will be seen that the light curve is a somewhat peculiar one, being remarkable for the very rapid rise from minimum to maximum. The decline too is very quick at first, becoming gradually slower and slower, whilst the star remains with but little change near minimum brightness during nearly half its period. The curve is thus almost a facsimile of that of *Y Lyræ.** Amongst isolated stars there seems to be only one other possessed of quite this extreme form of light curve and having a period of about half a day. This is *S Aræ.* The following is the description given by Dr. A. W. Roberts of the light changes undergone by this latter star. 'The remarkable feature about this star is its rapid rise to maximum. In $1^{h}\ 10^{m}$ it passes from its minimum to its maximum phase. The rate of increase is $0^{m}{\cdot}1$ every five minutes. After maximum passage the rate of variation steadily slows down till some three hours before minimum it is almost stationary.'† This description would apply equally well to either *UY Cygni* or *Y Lyræ*, with some little modifications arising from the slightly longer periods of these two stars. The resemblance is brought out very strikingly if the following elements of the three stars are placed parallel to each other.

	Y Lyræ	UY Cygni	S Aræ
Period	$12^{h}\ 3^{m}\ 52^{s}$	$13^{h}\ 27^{m}\ 21^{s}$	$10^{h}\ 50^{m}\ 47^{s}$
Duration of rise	$1^{h}\ 40^{m}$	$1^{h}\ 53^{m}$	$1^{h}\ 10^{m}$
Ratio increase to decrease	0·16	0·16	0·11
Range of variation ...	mag. 1·03	mag. 0·84	mag. 1·2

It is to this extreme type of variation combined with a period approximating to half a day that Professor S. I. Bailey seems to have applied the name of 'Cluster Type.'‡ But as regards the general *form* or characteristics of the light curve there would seem to be no essential difference between the above-mentioned three stars, or the stars of the so-called Cluster type, and the stars of the ordinary short period type, like δ *Cephei*, *T*

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* See *Monthly Notices*, vol. lxii. p. 206.

† *Astronomical Journal*, xxi. 91.

‡ *Astrophysical Journal*, x. 258. Dr Hartwig has used the term 'Antalgol-type' to designate the extreme type of variation exhibited by *Y Lyræ* and *UY Cygni.*

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Vulpeculæ, and others. The only material difference is that in the case of the average short period variable the ratio of the increase to the decrease averages about 0·34, as compared with 0·14, the average ratio in the case of the above-mentioned three stars, and that the period is also usually much longer. There is, however, no distinct line of demarcation between the two classes, and variables are to be met with in almost all the intermediate stages. Thus, the ratio of increase to decrease is 0·22 in the case of *V Velorum*; 0·23 in the case of *RV Scorpii*; 0·24 in the case of *U Triang. Austr.*; 0·27 for *V Centauri*; 0·29 for *T Moncerotis*; the same for *R Muscæ*; 0·30 for *δ Cephei*; 0·31 for *T Vulpeculæ* and *Y Sagittarii*. Also this ratio is 0·14 in the case of *U Carinæ*, although the period of this star is as long as 38·7 days. The mean ratio for 36 short period variables (not including *U Carinæ*, *S Aræ*, *Y Lyræ* and *UY Cygni*) is 0·34.* It appears, therefore, that the so-called 'Cluster type' is really only an extreme form of the ordinary short period type.† Nevertheless, as it is convenient to have some suitable term to designate this extreme type of short period variation, it seems desirable to retain the name of Cluster-type, unless that of Antalgol-type should be preferred.

It has already been mentioned that six observations were rejected for discordance. Five of these, near the maximum of 1902 June 11, were rejected on account of their being discordant *inter se*. The remaining case of discordance is somewhat peculiar. The observation was made on 1901 December 19, with the 2¾-inch refractor at $1^h\ 4^m$ before the computed time of maximum, and according to this observation the star had already attained to nearly its full brightness. The cause of this may possibly be that this maximum occurred, or the rise set in, a little earlier than usual; particularly since, as in the case of *Y Lyræ*,‡ there is some evidence to show that the maxima are not all quite alike, some being more accentuated than others. It is difficult, however, to decide how far such differences may not be due to subjective causes; and in the case of an isolated observation it is impossible to be certain of the absence of fog or cloud, even though none was noticed at the time.

Table IV. contains the full elements of the variable, and Table V. the computed heliocentric Greenwich mean times of every tenth maximum during the remainder of the present year.

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* These ratios have been derived from the data contained in Dr. Chandler's Third Catalogue of Variable Stars, and in Roberts' Catalogue of Southern Variable Stars in the *Astronomical Journal*, Nos. 491–492.

† I am indebted to Mr. P. S. Yendell, of Dorchester, Mass., U.S.A., for kindly drawing my attention to the similarity in the forms of the light curves of the 'Cluster type' and ordinary short period type of variation. Roberts has already remarked this in the case of *S Arae*.

‡ See *Monthly Notices*, lxii. 204.

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Table IV.

Elements of UY Cygni.

		day		h m s	
Period of variation ...	...	0·560658	=	13 27 20·85	
Epoch of T_0	...	1902 Aug. 22, = J.D. 2415984·4282		10 16·6	G.M.T.
Epoch of maximum ...	...	1902 Aug. 22, = J.D. 2415984·4841		11 37·1	,,
Maximum brightness...	...	9·66 mag.			
Minimum brightness ...	...	10·50 mag.			
Minimum to maximum	..	1^h 53^m			
Maximum to minimum	...	11^h 34^m			
Ratio increase to decrease	...	0·16			

Table V.

Computed Times of Maximum.

Ep.	Date. 1903.	G.M.T. h m	Ep.	Date. 1903.	G.M.T. h m
1548	April 9	8 30	1788	Aug. 21	21 53
1558	14	23 3	1798	27	12 26
1568	20	13 37	1808	Sept. 2	3 0
1578	26	4 10	1818	7	17 33
1588	May 1	18 43	1828	13	8 7
1598	7	9 17	1838	18	22 40
1608	12	23 50	1848	24	13 14
1618	18	14 24	1858	30	3 47
1628	24	4 57	1868	Oct. 5	18 21
1638	29	19 31	1878	11	8 54
1648	June 4	10 4	1888	16	23 28
1658	10	0 38	1898	22	14 1
1668	15	15 11	1908	28	4 35
1678	21	5 45	1918	Nov. 2	19 8
1688	26	20 18	1928	8	9 42
1698	July 2	10 52	1938	14	0 15
1708	8	1 25	1948	19	14 49
1718	13	15 59	1958	25	5 22
1728	19	6 32	1968	30	19 55
1738	24	21 6	1978	Dec. 6	10 29
1748	30	11 39	1988	12	1 2
1758	Aug. 5	2 13	1998	17	15 36
1768	10	16 46	2008	23	6 9
1778	16	7 19	2018	28	20 43

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Multiples of the Period.

		d	h	m			d	h	m
1p	=	0	13	27·3	6p	=	3	8	44·1
2	=	1	2	54·7	7	=	3	22	11·4
3	=	1	16	22·0	8	=	4	11	38·8
4	=	2	5	49·4	9	=	5	1	6·1
5	=	2	19	16·7	10	=	5	14	33·5

Hove: 1903 March 4.

Observations of Comet b 1902 (Perrine), from Photographs taken at the Royal Observatory, Greenwich.

(*Communicated by the Astronomer Royal.*)

The following table of Right Ascensions and Declinations of Comet *b* 1902 are, with the exception of those on September 6, 12, and 13, obtained from photographs with the 30-inch reflector. That on September 6 was taken with the astrographic equatorial, and those on September 12 and 13 with the 26-inch refractor. Owing to the rapid motion of the comet it was desirable to obtain photographs with shorter exposures than these instruments required, and accordingly from September 16 the reflector was used.

The number of exposures on each plate was in most cases four. The four images of the comet were measured in direct and reversed positions of the plate by Mr. Davidson and Mr. Melotte. Eight reference stars were measured, two of the images being measured direct and reversed by Mr. Davidson, and the other two by Mr. Melotte.

The catalogues of the *Astronomische Gesellschaft* were used for the positions of the reference stars, which were usually chosen so that their mean position should be near the centre of the plate. The stars were generally chosen between the limits 6 and 22 of the réseau, *i.e.* within 40′ from the central réseau lines, which are numbered 14.

The right ascensions and declinations of the comet given in the table are corrected for the part of the aberration which arises from the motion of the Earth, but not for the part arising from the movement of the comet itself. The corrections for parallax have not been applied.